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(54) Title: TREAD PATTERN FOR WINTER TIRES
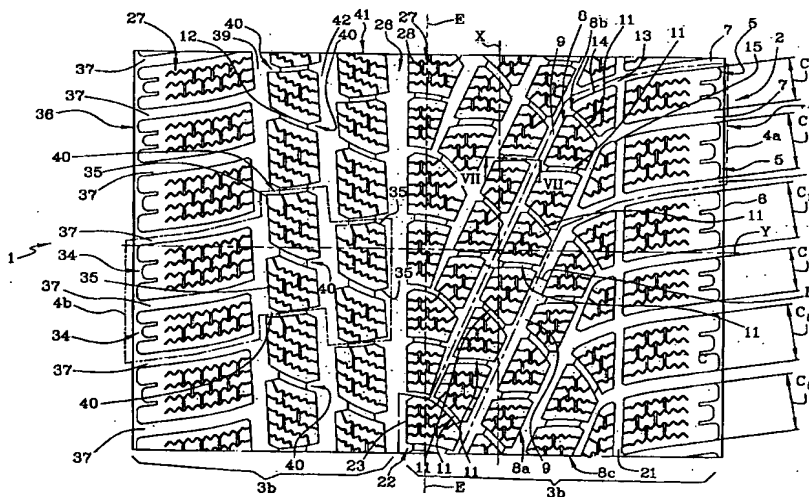
(57) Abstract: A tyre for vehicle wheels comprises a tread band (1) having a tread band pattern (2) defined by at least two circumferential portions (3) disposed in axial side by side relationship, at least *one* of which has a first geometric module (4) repeated many times along the circumferential extension direction (X) of the tyre. The first geometric module (4) comprises at least two shoulder blocks (5) circumferentially aligned along a side edge (6) of the tread band (1) and bounded by grooves (7) oriented transversely of the circumferential extension direction (X) of the tyre, and an elongated ridge (8) bounded by two grooves (9) 15 oblique to the circumferential extension direction (X) and divided into a plurality of intermediate blocks (10) with respect to the axial extension (Y) of the tread band (1), which are delimited by a plurality of cuts (11) substantially transverse to the elongated ridge (8).

WO 2004/056588 A1

TREAD PATTERN FOR WINTER TIRES

D e s c r i p t i o n

5　The present invention relates to a tyre for vehicle
wheels.

In more detail, the invention concerns a tyre of the
winter type for high performance and ultra high
10　performance cars, i.e. cars provided with particular
performance qualities and generally having a rear-wheel
drive.

By winter tyre it is intended a tyre provided with a
15　tread band suitable for running on surfaces of reduced
compactness in particular snow-covered roadways.

Tyres having the above qualities are usually required
to possess, together with optimal features in terms of
20　traction power, braking and handling on a snow-covered
roadway, a good behaviour on dry and wet roads and a
satisfactory resistance to wear. Noiseless running also
helps in elevating or worsening the qualitative
evaluation of a winter tyre.
25
Usually, the above mentioned behavioural and
operational features are determined through formation
in the tread band of appropriate circumferential and
transverse grooves suitably sized and oriented, which
30　grooves give rise to creation of blocks usually aligned
in rows disposed consecutively in side by side
relationship and extending circumferentially of the
tyre itself.

35　In addition, of decisive importance as regards the

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behavioural running features of a car on a snow-covered
roadway is the presence of an appropriate lamelliform
arrangement of cuts in the blocks, i.e. a thick series
of narrow cuts disposed consecutively in side by side
5   relationship in a circumferential direction and
oriented substantially transversely with respect to the
rolling direction. The task of these narrow cuts, which
are currently referred to as sipes, is substantially
that of effectively collecting and retaining the snow,
10 since friction of snow against snow is known to be
greater than rubber-on-snow friction.

In the international patent application WO 02/068222 in
the name of the same Applicant it is described a winter
15 tyre for vehicle wheels comprising a tread band
provided with three circumferential grooves and a
plurality of transverse grooves that together delimit
four circumferential rows of blocks: two axially
external shoulder rows and two central rows disposed to
20 the sides of the equatorial plane of the tyre. The
transverse grooves converge to the equatorial plane
towards a predetermined tyre-rolling direction. On the
tread band, each transverse groove belonging to the
central rows is provided with an enlarged area in its
25 section having an essentially circular profile, the
function of which is to entrap snow. In addition, for
obtaining rolling with less noise on dry roads as well,
each transverse edge of the blocks comprises at least
two successive curvilinear portions. These curvilinear
30 portions are differently shaped and have opposite bends
in the two portions to mitigate noise generated by the
impact of the blocks when the tyre is rolling on the
ground.

35 The Applicant has perceived the increasing requirement

of ensuring more handling on snow-covered roadways to all motor-vehicles and above all to those of the above . · mentioned high performance type, while at the same time affording more safety and comfort on dry and wet roads.

5

In fact many automobile houses during their winter tests have begun to regularly carry out behavioural tests on snow, beside the traditional acceleration and braking tests.

10

These tests are subjective behavioural tests and consist in the tyre being run on a mixed roadway, characterised by straight stretches and bends to be taken at different speeds, as well as by uphill and
15 downhill portions, on the basis of which a test driver gives his/her opinion on different car handling parameters.

In this connection the Applicant has found that the
20 winter tyres of the known art have a side (lateral) grip on snow-covered roadways that is not quite satisfactory. This phenomenon, present on both the car axles, is more marked on the driving wheels and is highlighted to a greater degree on rear-wheel drive
25 cars provided with engines of high power. In fact, to
ensure high performance on dry roadways, the cars of this type usually have low-section tyres, very large and stiff, having a footprint which is narrow in the circumferential direction and elongated (i.e.
30 wide) in the axial direction of the tyre. All these features however have the opposite effect when running on snow is concerned.

The lack of side grip adversely affects the traction
35 power on leaving a bend, giving rise to loss of grip of

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the rear axle of the car.

In addition, traditional block patterns for snow result in high noise when the tyre rolls on dry and compact
5   road surfaces, reaching peaks of high intensity at given frequencies connected with the number of blocks disposed on each circumferential row of the tread band.

The Applicant has found that these problems
10 particularly arise on vehicles in which the geometry of the suspensions imposes rather marked camber angles, for instance included between 0°,5' and 2°, typical of the above mentioned high performance cars. In more detail, the camber angle is the inclination of the
15 equatorial plane of a tyre from a direction normal to the road plane. In cars with a negative camber the tyre footprint has an amplitude increasingly growing towards the axially internal edge of the tyre, contrary to what happens to tyre footprints of cars with a
20 positive camber.

The Applicant has further noticed that known winter
.   tyres do not ensure the same performance level on dry roads as that obtainable with tyres expressly planned
25 for use on such types of roadway.

While trying to find a solution to the problems set out hereinabove, the Applicant has perceived that the presence of transverse cuts substantially extending
30 over the whole axial size of the tread band creates a
.   forced correlation between the number of blocks present in the different circumferential rows, which greatly contributes to the origin of the above described problems.
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- 5 -

The Applicant has therefore found the possibility of achieving important improvements in tyre behaviour as regards most of the problems found in the known art and correlated with side grip, handling, traction power
5   and braking on snow as well as in terms of noiseless running on a dry road, through accomplishment of a tread band pattern in which the number of blocks arranged in each circumferential row is not strictly conditioned by the number of blocks present in other
10   circumferential rows, for example in the shoulder rows.

Therefore, in accordance with the present invention, it is proposed a tyre for vehicle wheels comprising a tread band having a tread band pattern defined by at
15   least two circumferential portions disposed in axial side by side relationship, at least one of which has a first geometric module repeated many times along a circumferential-extension direction of the tyre and comprising: a land portion or elongated ridge delimited
20   by two grooves oblique to the circumferential-extension direction and divided into a plurality of intermediate blocks with respect to an axial-extension direction of the tread band, which are bounded by a plurality of cuts substantially transverse to the elongated ridge;
25   at least two shoulder blocks associated with the elongated ridge and circumferentially aligned along a side edge of the tread band and delimited by grooves oriented transversely to the circumferential extension of the tyre.
30
Further features and advantages will become more apparent from the detailed description of a preferred but not exclusive embodiment of a tyre for vehicle wheels in accordance with the present invention.
35

This description will be set out hereinafter with reference to the accompanying drawings given by way of non-limiting example, in which:

- Fig. 1 is a fragmentary plan view showing a tread
5 band of a tyre made in accordance with the present invention;·

- Fig. 2 shows in enlarged scale one geometric module of the tread band pattern of a first circumferential· portion of the tread band shown in Fig. 1;

10 - Fig. 3 shows in enlarged scale a second geometric module of the tread band pattern of a second circumferential portion of the tread band of Fig. 1;

- Fig. 4 shows a second embodiment of the tread band of Fig. 1;

15 - Fig. 5 shows a third embodiment of the tread band of Fig. 1;

- Fig. 6 shows a fourth embodiment of the tread band of Fig. 1; and

- Fig. 7 shows the longitudinal-section outline of a
20 cut sectioned along line VII-VII of Fig. 1.

Referring particularly to the above drawings, generally denoted at 1 is a tread band of a tyre·made in accordance with the present invention; the remaining
25 parts of the tyre are not highlighted since they can be made in any manner convenient for a person skilled in the art.

The tread band 1 has a tread band pattern 2 defined by
30 at least two circumferential portions 3a, 3b disposed in axial side by side relationship.

In at least one of the circumferential portions 3a, 3b, the tread band pattern is substantially defined by a
35 first geometric module 4a repeated many times along the

circumferential extension direction X of the tyre.

It is pointed out that by the term "geometric module"
it is herein meant a predetermined shape that is
5   repeated along the circumferential extension X of the
tyre. Geometric figures having the same shape, although
with different circumferential and/or axial sizes, are
at all events ascribable to a unique geometric module.
In particular, on repeating the geometric module,
10 different circumferential sizes following each other in
a predetermined sequence along the circumferential
extension of the tyre can be attributed to the shape
identifying the module so as to distribute the rolling
noise on a wider spectrum of frequencies, according to
15 a predetermined so-called "pitch sequence".

Advantageously, the first geometric module 4a has at
least two shoulder blocks 5 that are circumferentially
aligned along a side edge 6 of the tread band 2 and
20 bounded by grooves 7 oriented transversely to the
circumferential extension of the tyre.

The first geometric module 4a further has an elongated
ridge 8 delimited between two oblique grooves 9 with
25 respect to the circumferential extension direction X.
The elongated ridge 8 is divided into a plurality of
intermediate blocks 10 with respect to an axial
extension direction Y of the tread band 1, bounded by
cuts 11 substantially transverse to the elongated ridge
30 8.

In the embodiment shown in Figs. 1 and 2, six
intermediate blocks 10 are provided in each elongated
ridge 8. However ridges 8 with a different number of
35 blocks 10 can be made by suitably varying the sizes of

the blocks 10 themselves or the length of ridge 8 in compliance with the nominal width of the tyre.

By way of example, each transverse groove 7 and each
5 oblique groove 9 has a depth P1 included between 6 mm and 10 mm, and a width L1 included between 4 mm and 13 mm, measured on an outer rolling surface of the tread band 1. The depth and/or width of the transverse grooves 7 can not be the same as that of the oblique
10 grooves 9.

Cuts 11 have a depth P2 preferably smaller than that of grooves 7, 9 and included just as an indication between 2 mm and 10 mm, and a width L2 included, by way of
15 example, between 2 mm and 10 mm, and preferably lower than that of grooves 7 and 9.

In addition, to give the intermediate blocks 10 greater structural steadiness to the advantage of
20 handling, running noiselessness and wear evenness, the blocks themselves can be connected with each other by reinforcing elements 12 placed in cuts 11. In more detail, taking into account the longitudinal section of a cut 11, as shown in Fig. 7, each reinforcing element
25 can be defined by a portion of reduced depth arranged at the central region of the respective cut 11. The depth of cut 11 at the central region can be included, by way of example, between 1.5 mm and 9.5 mm.

30 In the embodiment herein illustrated, all intermediate blocks 10 are connected with each other by reinforcing elements 12 but the possibility of providing that only part of blocks 10 are connected with each other is not excluded.

35

Cuts 11 transverse to the elongated ridge 8 preferably comprise first cuts 11a substantially perpendicular to the circumferential extension X and second cuts 11b substantially perpendicular to the oblique grooves 9.

5 As a matter of fact, the transverse cuts 11 have a curved shape the concavity of which is turned in the same direction. Ascribed to each of them can be a median (meridian) line M_1 defined as a series of points spaced apart the same distance from the respective

10 edges of the cut.

The second cuts 11b have an inclination included between 25° and 55° with respect to the axial direction Y, wherein this inclination is represented by angle α_1

15 formed between the median line M_1 and the axial direction Y.

Advantageously, the first cuts 11a and second cuts 11b are disposed in an alternate sequence along a major

20 extension direction Z of the elongated ridge 8, so that each of the intermediate blocks 10 has a substantially trapezoidal shape.

Transverse cuts 11 all having the same inclination may

25 be also provided.

The oblique grooves 9 have an inclination included between 15° and 35° relative to the circumferential direction X, wherein this inclination is represented by

30 angle α_2 formed between the median line M_2, spaced apart the same distance from the edges 9a of the oblique groove 9, and the circumferential direction X.

The transverse grooves 7 are slightly curved and have

35 an inclination included between 75° and 105° relative

to the circumferential direction X, wherein this inclination is represented by angle α_3 formed between the median line M_3 as defined for the transverse cuts 11 of the elongated ridge 8, and the circumferential
5 direction X.

In the embodiments shown the oblique grooves 9 each have an orientation concordant with the transverse grooves 7 and run in the extension of one of the transverse grooves 7 themselves.
10

In particular, the elongated ridge 8 has an axially external end 13 located close to the tyre shoulder and substantially in alignment, in an axial direction, with one of the shoulder blocks 5. The axially
15 external end 13 of the elongated ridge 8 is defined by an end block 14 having a substantially trapezoidal shape.

The first geometric module 4a further comprises an
20 auxiliary block 15 disposed circumferentially close to the axially external end 13 of the elongated ridge 8 and substantially having a trapezoidal shape.

The auxiliary block 15 is bounded by a first branch 16
25 and a second branch 17 of the oblique groove 9 each terminating at one of the transverse grooves 7. Preferably, both the first branches 16 and the second branches 17 are substantially aligned with one of the transverse grooves 7, and the auxiliary block 15 is
30 substantially aligned, in an axial direction, with one of the shoulder blocks 5.

More specifically, the first branch 16 extending from an axially external end 18 of the oblique groove 9
35 delimits the end block 14 of the elongated ridge 8, on

one side 16a, and the auxiliary block 15, on the opposite side 16b.

The second branch 17 extending from an intermediate
5 point 19 located between the axially external end 18
and an axially internal end 20 of the oblique groove 9,
delimits the auxiliary block 15, on one side 17a, and
the end block 14 of the adjacent elongated ridge 8, on
the opposite side 17b.
10

The end block 14 and auxiliary block 15 appear as
appendices of the respective shoulder blocks 5 spaced
apart therefrom by a circumferential shoulder groove 21
separating the elongated ridges 8 from the shoulder
15 blocks themselves. The shoulder groove 21 has a width
included, just as an indication, between 1.5 mm and 6
mm and a depth included, by way of example, between 2
mm and 10 mm, preferably smaller than that of the
transverse groove 7 over at least part of the
20 circumferential extension of each shoulder block 5. The
first and second branches 16, 17 and the respective
transverse grooves 7 open into the circumferential
shoulder groove 21.

25 The elongated ridge 8 further has a swollen axially
internal end 22 in which at least two centre blocks 23,
24 are defined; said blocks are circumferentially
aligned and each have a substantially trapezoidal
shape.
30

The centre blocks 23, 24 are bounded by transverse cuts
25 converging into a circumferential separating groove
26 interposed between the circumferential portions 3a,
3b of the tread band pattern .

35

In particular, a first centre block 23 is separated from one of the intermediate blocks 10 by one of the second transverse cuts 11b. Also associated with the first centre block 23 is a second centre block 24

5 separated from the first centre block 23 by one of the transverse cuts 25 converging into the circumferential separating groove 26. Finally, the first centre block 23 is also delimited by one of the second centre blocks 24 which is circumferentially consecutive by means of

10 one of the transverse cuts 25.

Advantageously, as shown in Figs. 1 to 4, the shoulder blocks 5 do not all have the same circumferential size C along the circumferential tyre extension. The

15 elongated ridges 8 too have a varying transverse size depending on the size of the shoulder blocks 5 associated therewith. This is due to the fact that, as above mentioned, in repeating the geometric module along the circumferential tyre extension, the module

20 shape is preferably proposed again in several different forms mainly differentiated from each other in the size of the circumferential extension so that at least one of the two shoulder blocks 5 associated with one of the elongated ridges 8 has different circumferential sizes

25 C with respect to those of at least one of the two shoulder blocks 5 associated with at least one of the adjacent elongated ridges 8.

Furthermore, the two shoulder blocks 5 associated with

30 one individual elongated ridge 8 can have the same circumferential sizes C or different circumferential sizes C.

For example, denoted at 8a in Fig. 1 is an elongated

35 ridge the axially external end 13 of which is

associated with a shoulder block 5 having a circumferential size C_1 greater than the circumferential size C_2 of the shoulder block 5 aligned with the auxiliary block 15 belonging to the same geometric module. In addition, denoted at 8b is an elongated ridge the axially external end 13 of which is associated with a shoulder block 5 having a circumferential size C_3 smaller than the circumferential size C_4 of the shoulder block 5 aligned with the corresponding auxiliary block 15.

A further elongated ridge identified with 8c is also provided in which the shoulder blocks 5 all have the same circumferential size C_5.

The tread band 1 also has a plurality of sipes 27 formed in the different blocks 5, 10, 15, 23 and 24 and mainly extending in an axial direction.

Advantageously, each sipe 27 may extend following a sawtoothed profile the depth of which is in the range of 1.5 mm to 9.5 mm and the width of which does not exceed 1 mm. Furthermore, sipes 27 are circumferentially spaced apart from each other by a value D included between 4 mm and 8 mm.

The tread band 1 further has a plurality of notches 28 connecting sipes 27. In particular, two adjacent sipes 27 are connected by at least one connecting notch 28 having a substantially circumferential extension with a depth in the range of 1 mm to 3 mm and a width in the range of 1 mm to 2 mm, measured in an axial direction.

The connecting notches 28 generally do not connect more than two consecutive sipes 27 and do not open into the

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grooves 7, 9 and the cuts 11 delimiting the blocks.

In more detail, each of the shoulder blocks 5 has a first series 29 of sipes 27 disposed according to an
5 extension substantially parallel to the transverse grooves 7.

The intermediate blocks 10 each have a second series 30 of sipes 27 disposed parallel to each other mainly in
10 an axially-extending direction.

The centre blocks 23, 24 each have a third series 31 of sipes 27 disposed parallel to each other mainly in an axially-extending direction.
15

Finally, the end blocks 14 and auxiliary blocks 15 each have a fourth series 32 of sipes 27 disposed according to an extension substantially parallel to the transverse grooves 7.
20

In the embodiments shown, each of the shoulder blocks 5, end blocks 14 and auxiliary blocks 15 is provided with three or four sipes 27. Each of the centre blocks 23, 24 has four or five sipes 27. The intermediate
25 blocks 10 each have four sipes 27.

Advantageously, as shown in Figs. 1 to 4, the tread band pattern 2 comprises a first circumferential portion 3a and a second circumferential portion 3b
30 disposed in side by side relationship and spaced apart from each other by the circumferential separating groove 26.

Advantageously, the separating groove 26 can be spaced
35 apart from the equatorial plane E of the tyre (Figs. 1

and 4) towards one or the other of the tyre shoulders, by an amount for example included between 2% and 8% of the overall width of the tread band 1.

5   In the second circumferential portion 3b, the tread band is defined by a second geometric module 4b repeated many times along the circumferential tyre extension.

10 In accordance with the embodiment shown in Fig. 1, the first circumferential portion 3a of the tread band pattern 2 has the same structure as hitherto described whereas the second geometric module 4b of the second circumferential portion 3b comprises two shoulder
15 blocks 34 and four inner blocks 35 (Fig. 3).

Repeating the second geometric module 4b along the circumferential extension X gives origin to a plurality of shoulder blocks 34 arranged along a single row, and
20 to a plurality of inner blocks 35.

Also the shoulder blocks 34 and inner blocks 35 of the second geometric module 4b in accordance with the embodiments shown in Figs. 1, 3 and 4 do not all have
25 the same circumferential size C along the tyre extension.

The shoulder blocks 34 of the second circumferential portion 3b in accordance with the preferred embodiment
30 are circumferentially aligned along a side edge 36 of the tread band 1, axially opposite to the side edge 6 of the first circumferential portion 3a, and confined by grooves 37 oriented transversely of the circumferential tyre extension.

35

More specifically, the transverse grooves 37 are slightly curved and have an inclination included between 75° and 105° with respect to the circumferential direction X, wherein said inclination

5 is represented by angle α_4 formed between the medial line M_4, as defined for the transverse cuts 11 of the elongated ridge 8, and the circumferential direction X itself.

10 The inner blocks 35 are distributed along at least one first circumferential row 38 separated from the shoulder blocks 34 of the second circumferential portion 3b by a circumferential shoulder groove 39 and are delimited by grooves 40 oriented transversely to

15 the circumferential tyre extension.

Preferably, the second circumferential portion 3b of the tread band pattern 2 further comprises a second circumferential row 41 of inner blocks 35 disposed in

20 axial side by side relationship with the first row 38 and separated therefrom by a circumferential groove 42.

In further embodiments not shown, the tyre can be provided with more than two circumferential rows of

25 inner blocks 35, for example along the nominal chord of the tyre itself.

Just as an indication, grooves 37, 39, 40, 42 of the second circumferential portion 3b and the separating

30 groove 26 do not necessarily have the same depth P3, said depth being preferably included between 6 mm and 10 mm.

The inner blocks 35 of each row 38, 41 can

35 advantageously be connected with each other by

reinforcing elements 12 similar to the reinforcing elements 12 used for the intermediate blocks 10 of the elongated ridges 8.

5   In addition, the transverse grooves 37 of the shoulder blocks 34, the circumferential grooves 39, 42 and separating groove 26 do not necessarily have the same width L3, said width being preferably included between 4 mm and 13 mm, measured on an outer rolling surface of
10 the tread band 1.

Finally, the transverse grooves 40 of the inner blocks 35 have a width L4 included between 2 mm and 10 mm, generally smaller than the width L3 typical of grooves
15 37 in the shoulder blocks 34, as well as of the circumferential grooves 39, 42 and separating groove 26. Advantageously, the transverse grooves 40 bounding the inner blocks 35 of the first row 38 are circumferentially offset with respect to the transverse
20 grooves 37 of the shoulder blocks 34 of the second circumferential portion 3b and, where the second row 41 is also provided, with respect to the transverse grooves 40 bounding the inner blocks 35 of the second row 41.

25

Between the transverse grooves 40 delimiting the inner blocks 35 are provided first grooves 40a that are inclined to the axial direction Y and second grooves 40b substantially perpendicular to the circumferential
30 tyre extension. The first grooves 40a and second grooves 40b are disposed in an alternate sequence along the respective circumferential row 38, 41, so as to give the inner blocks 35 a substantially trapezoidal shape.

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More specifically, the transverse grooves 40 have a curved shape the concavity of which is turned in the same direction. A median line defined as the series of points spaced apart the same distance from the

5   respective edges of the groove can be ascribed to each of said grooves.

The first grooves 40a are inclined to the axial direction Y by an angle included between 25° and 55°,

10 wherein said inclination is represented by angle α_5 formed between the median line M_5 and the axial direction Y.

The second grooves 40b too are inclined to the axial

15 direction Y by an angle included between 5° and 20°, wherein this inclination is represented by angle α_6 formed between the median line M_6 and the axial direction Y.

20 Preferably, the first grooves 40a delimiting the inner blocks 35 of the first circumferential row 38 and the first grooves 40a delimiting the inner blocks 35 of the second circumferential row 41 are parallel to each other.

25

Alternatively, according to an embodiment not shown, the first grooves 40a delimiting the inner blocks 35 of the first circumferential row 38 and the first grooves 40a delimiting the inner blocks 35 of the second

30 circumferential row 41 symmetrically converge towards the circumferential groove 42 separating the first row 38 from the second row 41.

The possibility of providing grooves 40 all having the

35 same inclination is not to be excluded.

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Advantageously, the inner blocks 35 and shoulder blocks
34 have their longitudinal sides 35a, 34a, i.e. those
sides substantially oriented in the circumferential
5 direction X, inclined to the circumferential direction
X itself by an angle α_7 included between 1° and 5° so
as to generate widened portions 45 in the
circumferential grooves 39, 41 belonging to the second
circumferential portion 3b and in the separating groove
10 26. The transverse grooves 40 delimiting the inner
blocks 35 open into these widened portions 45. In
addition, to increase amplitude of the widened portions
45, at least one of the corners of the inner blocks 35
facing said portion 45 is rounded off at 46 so as to
15 offer more room for snow entrapping.

In accordance with the embodiment shown in Fig. 1, the
transverse grooves 37 in the shoulder blocks 34 of the
second circumferential portion 3b and the transverse
20 grooves 7 of the shoulder blocks 5 of the first
circumferential portion 3a are substantially parallel,
to give origin to a tyre of the asymmetric and non-
directional type.

25 Alternatively, according to a second embodiment shown
in Fig. 4, the transverse grooves 37 of the shoulder
blocks 34 of the second circumferential portion 3b and
the transverse grooves 7 of the shoulder blocks 5 of
the first circumferential portion 3a converge towards
30 each other, to give origin to a tyre of the asymmetric-
directional type.

In both the embodiments shown in Figs. 1 and 4 the
second circumferential portion 3b too is provided with
35 a plurality of sipes 27 extending according to a

sawtoothed profile and mutually connected by a plurality of notches 28 in the same manner as described for the first geometric module 4a. Sipes 27 of the second circumferential portion 3b have a depth included 5 between 1.5 mm and 9.5 mm and a width not exceeding 1 mm.

In particular, each of the shoulder blocks 34 of the second circumferential portion 3b has a fifth series 47 10 of sipes 27 disposed substantially parallel to the transverse grooves 37 delimiting the shoulder blocks 34 themselves. The shoulder blocks 34 of the second circumferential portion 3b as well have circumferential sizes different from each other and are provided with 15 three or four sipes 27 depending on their circumferential size.

In addition, advantageously, each of the inner blocks 35 of the first circumferential row 38 has a sixth 20 series 48 of sipes 27 disposed parallel to each other and the extension of which is oblique to the axial direction Y and parallel to the first grooves 40a in the inner blocks 35 of the first circumferential row 38.
25

Preferably, as shown in Figs. 1, 3 and 4, the first row 38 has inner blocks 35 with five sipes 27, and inner blocks 35 with four sipes 27.

30 The inner blocks 35 of the second circumferential row 41 each have a seventh series 49 of sipes 27 disposed parallel to each other and having an extension oblique to the axial direction Y and parallel to the first grooves 40a in the inner blocks 35 of the second 35 circumferential row 41.

The second row 41 too has inner blocks 35 with five sipes 27, and inner blocks 35 with four sipes 27.

5 Finally, as can be viewed from Figs. 1 and 4, the number of the shoulder blocks 34 of the second circumferential portion 3b is the same as the number of the inner blocks 35 of the first circumferential row 38 and as the number of the inner blocks 35 of the second

10 circumferential row 41, and is twice the number of the elongated ridges 8 of the first circumferential portion 3a.

In accordance with a third embodiment and a fourth

15 embodiment, shown in Figs. 5 and 6 respectively, the second geometric module 4b of the second circumferential portion 3b of the tread band pattern 2 is similar in structure to the geometric module 4a of the first portion 3a.

20

In particular, the second geometric module 4b too comprises at least two shoulder blocks 5 circumferentially aligned along a side edge 36 of the tread band 1 axially opposite to the side edge 6

25 belonging to the first geometric module 4a and bounded by grooves 7 oriented transversely to the circumferential tyre extension. The second geometric module 4b further comprises an elongated ridge 8 delimited by two oblique grooves 9 with respect to the

30 circumferential extension direction X and divided into a plurality of blocks 10 disposed at an intermediate position in the axial extension of the tread band 1 and delimited by a plurality of cuts 11 substantially transverse to the elongated ridge 8.

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In the third embodiment shown in Fig. 5, the oblique grooves 9 of the second geometric module 4b converge towards the oblique grooves 9 of the first geometric module 4a to form a tyre of the directional type. In

5 the particular embodiment shown, the second geometric module 4b is symmetric with the first geometric module 4a with respect to the equatorial plane E of the tyre and is also circumferentially offset relative to the first geometric module itself.

10

In a fourth embodiment shown in Fig. 6, the oblique grooves 9 of the second geometric module 4b are substantially parallel to the oblique grooves 9 of the first geometric module 4a, to create a tyre of the

15 symmetric type.

In the particular embodiment shown, the second geometric module 4b is identical to the first geometric module 4a, but rotated of 180° in the plane of the

20 fugure and circumferentially offset relative to the first geometric module itself.

In further embodiments not shown the geometric modules 4a, 4b of the two circumferential portions 3a, 3b,

25 while having the same structure, can advantageously have different sizes, particularly in relation to the length of the elongated ridges 8.

The present invention thus achieves the intended

30 purposes.

The innovative expedients proposed by the invention, in fact, give rise to important improvements in terms of side grip of the tyre on roadways of reduced

35 compactness, in particular on snow-covered surfaces,

together with excellent qualities in terms of traction
power and braking due in particular to the conformation
of the first geometric module 4a adopted for the
circumferential portion 3a shown in Fig. 1, and to the
5   synergic co-operation with the second geometric module
4b.

In fact, due to the presence of cuts and grooves
transverse to the axial direction, a remarkable surface
10 for ground contact and snow accumulation is offered
when the tyre is submitted to side forces. The presence
of sawtoothed sipes also helps in achieving this
result. Simultaneously, the transverse cuts and
transverse grooves work, together with the cuts
15 parallel to the axial direction, in order to supply
traction power and grip on braking.

In addition, the oblique grooves ensure an efficient
water ejection that helps in avoiding occurrence of the
20 dangerous phenomenon known as "aquaplane".

It should be also understood that distribution of the
blocks internal to the elongated ridges and of the
shoulder blocks, as well as the inclination of same
25 relative to the circumferential direction give rise to
a noise spectrum distributed over a wide frequency band
and of reduced intensity, thereby greatly reducing the
rolling noise felt both internally and externally of
the car. In fact, the number of points belonging to the
30 edges of the blocks simultaneously coming into contact
with the ground during rolling of the tyre is very
reduced.

Simultaneously, the particular pattern of the first
35 geometric module 4a at all events ensures a large

contact surface between tyre and asphalt and consequently a performance level on dry roadways comparable with that ensured by a tread pattern expressly designed for such conditions.

5

Referring particularly to the embodiment of Fig. 1 and to the second embodiment of Fig. 2, differentiation of the two circumferential portions with the inner portion characterised by elongated ridges enables an optimised

10 tyre for high performance cars with negative camber to be obtained. In fact, the two portions embody different features and, being applied simultaneously, ensure an optimal performance in all tests for tyre evaluation.

15 The outer portion works principally during changes of direction on snow-covered roadways, in particular on leaving a bend, since the snow bears against the shoulder blocks and inner blocks and is entrapped into the labyrinth path generated by them and into the

20 greatly inclined sipes. The inner portion which, as already specified, represents the largest part of the footprint area, ensures a good behaviour on dry or wet roads as well.

25 Finally, distribution of the cuts and grooves following different inclinations over the whole extension of the tread band enables tendency of the tyre during rolling to rotate about an axis orthogonal to the rest surface to be minimised, which effect is known in the specific

30 field as "torque steer".

In confirmation of the above mentioned advantages, two tables are reproduced hereinafter which relate to comparison tests between the tyre (P) of the present

35 invention and three different tyres of the known art

(Pr, P1, P2) having the same sizes 205/55 R16. Tyre Pr is a reference tyre produced by the Applicant and has the same structure and elastomer composition, in the different component elements thereof, of the inventive
5 tyre. Tyres P1 and P2 are two reference tyres representing the two best tyres available from competitor firms and presently on the market.

The tyres were tested both on a snow-covered roadway
10 and a dry road, using the same motor-vehicle and under the same environmental conditions. In particular, tests were conducted utilising a BMW 328i car (rear-wheel drive) and an Audi A3 1.8T car (front-wheel drive).

15 The values reproduced in the following tables represent a mean value between those obtained in several test sessions (5 - 6 tests, for example) using both the above mentioned cars.

20 In particular, tyres were submitted to instrument tests on traction, braking and slalom on a snow-covered roadway; to braking tests on a dry roadway; to noise tests; to aquaplane tests on a bend and on a straight stretch.
25

The above tyres were further submitted to subjective tests on traction, braking and handling on a snow-covered roadway; to handling tests on a dry and a wet roadway; and to noise tests, writing down the test
30 drivers' subjective evaluations (expressed through a point system).

Table 1 refers to instrument tests, whereas Table 2 reproduces the test drivers' subjective evaluations.
35

The traction tests on a snow-covered roadway were conducted carrying out first-gear standing starts. With reference to Table 1, the maximum traction force of tyres P, P1, P2 was measured and expressed as a percentage of the maximum traction force of the reference tyre Pr.

Braking tests on a snow-covered roadway were carried out with deceleration from 50 to 5 km/h by using both the antilock braking system (ABS) and locked-wheel system.

Braking tests on dry asphalt were conducted with decelerations from 100 to 5 km/h by using the ABS system.

The average deceleration of tyres P, P1, P2 was measured and expressed as a percentage of the maximum deceleration of the reference tyre Pr.

The slalom test on a snow-covered roadway was conducted between ten traffic cones placed at a distance of eighteen metres from each other and at a speed included between 35 and 45 km/h; the maximum side acceleration of tyres P, P1, P2 during the slalom test was measured and expressed as a percentage of the maximum acceleration of the reference tyre Pr.

The aquaplane test on a straight stretch was carried out on a smooth asphalt stretch (100 m long, for example) covered with a water layer of constant depth (7 mm). The water layer was restored after each passage so as to ensure the same conditions during each test. The test was conducted by making the vehicle to enter the asphalt stretch at a constant speed (70 km/h, for example) under optimal grip conditions and by progressively accelerating the vehicle until reaching

– 27 –

conditions of complete grip loss. During the test the speed at which all wheels lose grip was measured and this speed was expressed as a percentage of the maximum speed of the reference tyre Pr.

5

The aquaplane test on a bend was carried out on a curvilinear path of constant radius (of 100 m) the final stretch of which (over a portion 20 m long, for example) was covered with a water layer of constant
10 depth (7 mm deep). The test was conducted at a constant speed and repeated for different speed values. The maximum speed and maximum acceleration of the car on the bend were measured before grip loss and these values were expressed as a percentage of the maximum
15 speed and maximum acceleration of the reference tyre Pr.

The outdoor noise test (the term "outdoor" being used to distinguish it from the indoor noise test carried
20 out in a semi-anechoic chamber) was conducted in order to evaluate both the internal noise of the car and the external noise of same.

In order to evaluate the internal noise of the car, the
25 test consisted in driving the car at a predetermined constant speed and subsequently making the car to run a straight stretch with a switched-off engine and in neutral (this test is called "coast by noise"). The test is repeated driving the car at different speeds.
30 When cars were run on this straight stretch with a switched-off engine and in neutral, the internal noise of the car was instrumentally measured by use of a so-called "acoustic head" simulating the driver/passenger position within the car by means of microphones
35 positioned at the ear height. The test further

- 28 -

consisted in a subjective evaluation (expressed through a point system) carried out by the test driver having the task of evaluating the noise level perceived within the car.

5

This test was further conducted making the car to travel over said straight stretch at constant speed, without switching the engine off. In addition, this test was repeated on different asphalt typologies.

10

In order to evaluate the noise external to the car, the test consisted in causing the car to run over a straight stretch provided with microphones disposed on opposite sides of said stretch.

15

The test was conducted following two different modalities: a) imposing an acceleration to the car while said car was covering the above mentioned stretch (this test is called "pass by noise"); b) bringing the

20 vehicle to a constant speed, by switching the engine off and putting it in neutral at the above mentioned straight stretch.

The handling tests were conducted on a track and the

25 test driver simulated some characteristic manoeuvring (change of lane, entering a bend, leaving a bend, for example) carried out at constant speed, in acceleration and in deceleration. Then test driver judged the tyre behaviour and assigned a score depending on the tyre

30 performance during said manoeuvring.

The average scores given by several test drivers to the different performance tests taken into account are reproduced in Table 2.

35

In the tables it is possible to see that the tyre of the present invention has higher scores than the tyres of the known art.

5   The values reproduced in the tables are expressed in relation to the value of 100 given to the reference tyre Pr.

Table 1 – Instrument tests

	P	Pr	P1	P2
Traction on snow	105	100	101	98
Braking on snow	102	100	98	100
Slalom on snow	106	100	100	97
Braking on dry asphalt	101	100	101	100
Aquaplane on a bend	104	100	101	98
Aquaplane in straight stretch	103	100	102	97
Outdoor noise (internal noise)	107	100	95	98
Outdoor noise (external noise)	105	100	98	100

10

Table 2 – Subjective tests

	P	Pr	P1	P2
Traction on snow	108	100	101	99
Braking on snow	103	100	98	101
Handling on snow	108	100	102	102
Handling on a dry roadway	105	100	98	100
Handling on a wet roadway	105	100	99	98
Outdoor noise on smooth/coarse asphalt	108	100	96	99

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C L A I M S

1. A tyre for vehicle wheels, comprising a tread band
(1) having a tread band pattern (2) defined by at least
5   two circumferential portions (3) disposed in axial side
by side relationship, at least one of said portions
having a first geometric module (4) repeated many times
along a circumferential extension direction (X) of the
tyre and comprising:
10 - an elongated ridge (8) bounded by two grooves (9)
oblique to the circumferential extension direction (X),
and divided into a plurality of intermediate blocks
(10) with respect to an axial extension direction (Y)
of the tread band (1), which are delimited by a
15 plurality of cuts (11) substantially transverse to the
elongated ridge (8);
- at least two shoulder blocks (5) associated with the
elongated ridge (8), circumferentially aligned along a
side edge (6) of the tread band (1) and bounded by
20 grooves   (7)   oriented   transversely   to   the
circumferential tyre extension (X).

2. A tyre as claimed in claim 1, further comprising at
least one circumferential groove (26) separating said
25 circumferential portions (3) of the tread band pattern
(2).

3. A tyre as claimed in claim 2, wherein the
circumferential separating groove (26) is spaced apart
30 from the equatorial plane of the tyre.

4. A tyre as claimed in claim 1, wherein the oblique
grooves (9) have an inclination included between 15°
and 35° relative to the circumferential direction (X).

35

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5. A tyre as claimed in claim 1, wherein the transverse grooves (7) have an inclination included between 75° and 105° relative to the circumferential direction (X).

5   6. A tyre as claimed in claim 1, wherein the tread band pattern (2) further comprises at least one circumferential shoulder groove (21) separating the elongated ridges (8) from the shoulder blocks (5).

10   7. A tyre as claimed in claim 1, wherein said intermediate blocks (10) each have a substantially trapezoidal shape.

8. A tyre as claimed in claim 1, wherein the elongated
15 ridge (8) has a swollen axially internal end (22) in which at least two centre blocks (23, 24) circumferentially aligned with each other are defined.

9. A tyre as claimed in claim 8, wherein the centre
20 blocks (23, 24) have a substantially trapezoidal shape.

10. A tyre as claimed in claim 9, wherein the centre blocks (23, 24) are bounded by transverse cuts (25) converging into a circumferential separating groove
25 (26) interposed between the circumferential portions (3) of the tread band pattern (2).

11. A tyre as claimed in claim 1, wherein the two shoulder blocks (5) associated with the elongated ridge
30 (8) have the same circumferential size (C).

12. A tyre as claimed in claim 1, wherein the two shoulder blocks (5) associated with the elongated ridge (8) have different circumferential sizes (C).

35

13. A tyre as claimed in claim 1, wherein the two shoulder blocks (5) associated with one of the elongated ridges (8) have different circumferential sizes (C) than the two shoulder blocks (5) associated
5 with at least one of the adjacent elongated ridges (8).

14. A tyre as claimed in claim 1, wherein the elongated ridge (8) has an axially external end (13) substantially in axial alignment with one of said
10 shoulder blocks (5).

15. A tyre as claimed in claim 14, wherein the axially external end (13) of the elongated ridge (8) is defined by an end block (14) having a substantially trapezoidal
15 shape.

16. A tyre as claimed in claim 14, wherein the first geometric module (4) further comprises an auxiliary block (15) disposed circumferentially close to the
20 axially external end (13) of the elongated ridge (8).

17. A tyre as claimed in claim 16, wherein the auxiliary block (15) is substantially in axial alignment with one of said shoulder blocks (5).
25
18. A tyre as claimed in claim 16, wherein the auxiliary block (15) is delimited by a first (16) and a second (17) branches of the oblique groove (9), each of them opening into one of said transverse grooves (7).
30
19. A tyre as claimed in claim 18, wherein each of said first (16) and second (17) branches is substantially in alignment with one of the transverse grooves (7).

35 20. A tyre as claimed in claim 16, wherein the

auxiliary block (15) has a substantially trapezoidal
shape.

21. A tyre as claimed in claim 17, wherein the shoulder
block (5) associated with the axially external end (13)
of the elongated ridge (8) has a circumferential size
(C_1) greater than the circumferential size (C_2) of the
shoulder block (5) aligned with the auxiliary block
(15).

22. A tyre as claimed in claim 17, wherein the shoulder
block (5) associated with the axially external end (13)
of the elongated ridge (8) has a circumferential size
(C_3) smaller than the circumferential size (C_4) of the
shoulder block (5) aligned with the auxiliary block
(15).

23. A tyre as claimed in claim 1, wherein the cuts (11)
transverse to the elongated ridge (8) are comprised of
first cuts (11a) substantially perpendicular to the
circumferential extension direction (X), and second
cuts (11b) substantially perpendicular to the oblique
grooves (9).

24. A tyre as claimed in claim 23, wherein the first
cuts (11a) and second cuts (11b) are disposed in an
alternate sequence along a major extension direction
(Z) of the elongated ridge (8).

25. A tyre as claimed in claim 1, wherein the tread
band (1) further has a plurality of sipes (27).

26. A tyre as claimed in claim 25, wherein the sipes
(27) are formed on each geometric module (4) in a
mainly axial extension.

27. A tyre as claimed in claim 25 or 26, wherein each of the sipes has a sawtoothed profile.

28. A tyre as claimed in claim 25, wherein the tread
5 band (1) further has a plurality of connecting notches (28) between the sipes (27).

29. A tyre as claimed in claim 1, wherein the shoulder blocks (5) each have a first series (29) of sipes (27)
10 having a sawtoothed profile and disposed parallel to each other according to an extension substantially parallel to the transverse grooves (7).

30. A tyre as claimed in claim 1, wherein the
15 intermediate blocks (10) each have a second series of sipes (27) having a sawtoothed profile and disposed parallel to each other in a mainly axial extension.

31. A tyre as claimed in claim 8, wherein the centre
20 blocks (23, 24) each have a third series (31) of sipes (27) having a sawtoothed profile and disposed parallel to each other in a mainly axial extension.

32. A tyre as claimed in claim 16, wherein each of the
25 end blocks (14) and each of the auxiliary blocks (15) have a fourth series (32) of sipes (27) having a sawtoothed profile and disposed parallel to each other according to an extension substantially parallel to the transverse grooves (7).
30
33. A tyre as claimed in claim 1, wherein the oblique grooves (9) each run in the extension of one of the transverse grooves (7).

35 34. A tyre as claimed in claim 1, wherein the tread

band pattern (2) comprises a second circumferential portion (3b) having a second geometric module (4b) repeated many times along the circumferential extension direction (X) of the tyre and comprising:

5 - an elongated ridge (8) bounded by two grooves (9) oblique to the circumferential extension direction (X) and divided into a plurality of intermediate blocks (10) with respect to an axial extension (Y) of the tread band (1), which are delimited by a plurality of

10 cuts (11) substantially transverse to the elongated ridge (8);

- at least two shoulder blocks (5) associated with the elongated ridge (8), circumferentially aligned along a side edge (6) of the tread band (1), and confined by

15 grooves (7) oriented transversely of the circumferential extension direction (X) of the tyre.

35. A tyre as claimed in claim 34, wherein the oblique grooves (9) of the second geometric module (4b)

20 converge towards the oblique grooves (9) of the first geometric module (4a).

36. A tyre as claimed in claim 34, wherein the oblique grooves (9) of the second geometric module (4b) are

25 substantially parallel to the oblique grooves (9) of the first geometric module (4a).

37. A tyre as claimed in claim 34, wherein the first geometric module (4a) is circumferentially offset

30 relative to the second geometric module (4b).

38. A tyre as claimed in claim 1, wherein the tread band pattern (2) comprises a second circumferential portion (3b) having:

35 - a plurality of shoulder blocks (34) circumferentially

aligned along a side edge (36) of the tread band (1)
and delimited by grooves (37) oriented transversely of
the circumferential extension (X) of the tyre;
- a plurality of inner blocks (35) distributed along at
5 least one circumferential row (38) separated from the
shoulder blocks (34) of the second circumferential
portion (3b) by a circumferential shoulder groove (45),
said inner blocks (35) being bounded by grooves (40)
oriented transversely to the circumferential extension
10 direction (X) of the tyre.

39. A tyre as claimed in claim 38, wherein the second
circumferential portion (3b) of the tread band pattern
(2) further comprises a second circumferential row (41)
15 of inner blocks (35) disposed in axial side by side
relationship with the first row (38) and separated from
said first row (38) by a circumferential groove (42).

40. A tyre as claimed in claim 38, wherein the
20 transverse grooves (40) delimiting the inner blocks
(35) are circumferentially offset relative to the
transverse grooves (37) of the shoulder blocks (34) of
the second circumferential portion (3b).

25 41. A tyre as claimed in claim 39, wherein the
transverse grooves (40) delimiting the inner blocks
(34) of the first row (38) are circumferentially offset
relative to the transverse grooves (40) delimiting the
inner blocks (35) of the second row (41) and relative
30 to the transverse grooves (37) of the shoulder blocks
(34) of the second circumferential portion (3b).

42. A tyre as claimed in claim 38 or 39, wherein the
transverse grooves (40) delimiting the inner blocks
35 (35) have first grooves (40a) inclined to the axial

direction (Y) and second grooves (40b) substantially perpendicular to the circumferential extension direction (X) of the tyre.

5   43. A tyre as claimed in claim 42, wherein the first grooves (40a) of the inner blocks (35) are inclined to the axial direction (Y) by an angle (α_5) included between 25° and 55°.

10 44. A tyre as claimed in claim 42, wherein the second grooves (40b) of the inner blocks (35) are inclined to an axial direction (Y) by an angle (α_6) included between 5° and 20°.

15 45. A tyre as claimed in claim 42, wherein the first grooves (40a) and second grooves (40b) delimiting the inner blocks (35) are disposed in an alternate sequence along the respective circumferential row (38; 41).

20 46. A tyre as claimed in claim 42, wherein the first grooves (40a) delimiting the inner blocks (35) of the first circumferential row (38) and the first grooves (40a) delimiting the inner blocks (35) of the second circumferential row (41) are parallel to each other.

25
47. A tyre as claimed in claim 38 or 39, wherein the inner blocks (35) have a trapezoidal shape.

48. A tyre as claimed in claim 38 or 39, wherein the
30 inner blocks (35) have longitudinal sides (35a) inclined to the circumferential direction (X).

49. A tyre as claimed in claim 48, wherein the longitudinal sides (35a) of the inner blocks (35) are
35 inclined to the circumferential direction (X) by an

angle (α_7) included between 1° and 5°

50. A tyre as claimed in claim 38 or 39 wherein the transverse grooves (37) of the shoulder blocks (34) of
5 the second circumferential portion (3b) are inclined to the circumferential direction (X) by an angle (α_4) included between 75° and 105°.

51. A tyre as claimed in claim 38 or 39, wherein the
10 transverse grooves (37) of the shoulder blocks (34) of the second circumferential portion (3b) and the transverse grooves (7) of the shoulder blocks (5) of the first circumferential portion (3a) converge towards each other.
15

52. A tyre as claimed in claim 38 or 39, wherein the transverse grooves (37) of the shoulder blocks (34) of the second circumferential portion (3b) and the transverse grooves (7) of the shoulder blocks (5) of
20 the first circumferential portion (3a) are substantially parallel.

53. A tyre as claimed in claim 38, wherein the shoulder blocks (34) of the second circumferential portion (3b)
25 have different circumferential sizes from each other.

54. A tyre as claimed in claim 38 or 39, wherein the shoulder blocks (34) of the second circumferential portion (3b) each have a fifth series (47) of sipes
30 (27) having a sawtoothed profile and disposed according to an extension substantially parallel to the transverse grooves (37) delimiting said shoulder blocks (34) of the second circumferential portion (3b).

35 55. A tyre as claimed in claim 42, wherein the inner

blocks (35) of the first circumferential row (38) each
have a sixth series (48) of sipes (27) having a
sawtoothed profile and disposed parallel to each other
according to an extension oblique to the axial
5   direction (Y).

56. A tyre as claimed in claim 55, wherein the sipes
(27) of the sixth series (48) extend parallel to the
first grooves (40a) delimiting the inner blocks (35) of
10 the first circumferential row (38).

57. A tyre as claimed in claim 42, wherein the inner
blocks (35) of the second circumferential row (41) each
have a seventh series (49) of sipes (27) having a
15 sawtoothed profile and disposed parallel to each other
according to an extension oblique to the axial
direction (Y).

58. A tyre as claimed in claim 57, wherein the sipes
20 (27) of the seventh series (49) extend parallel to the
first grooves (40a) delimiting the inner blocks (35) of
the second circumferential row (41).

59. A tyre as claimed in claim 39, wherein the number
25 of the shoulder blocks (34) of the second
circumferential portion (3b) is the same as the number
of the inner blocks (35) of the first circumferential
row (38), the same as the number of the inner blocks
(35) of the second circumferential row (41), and twice
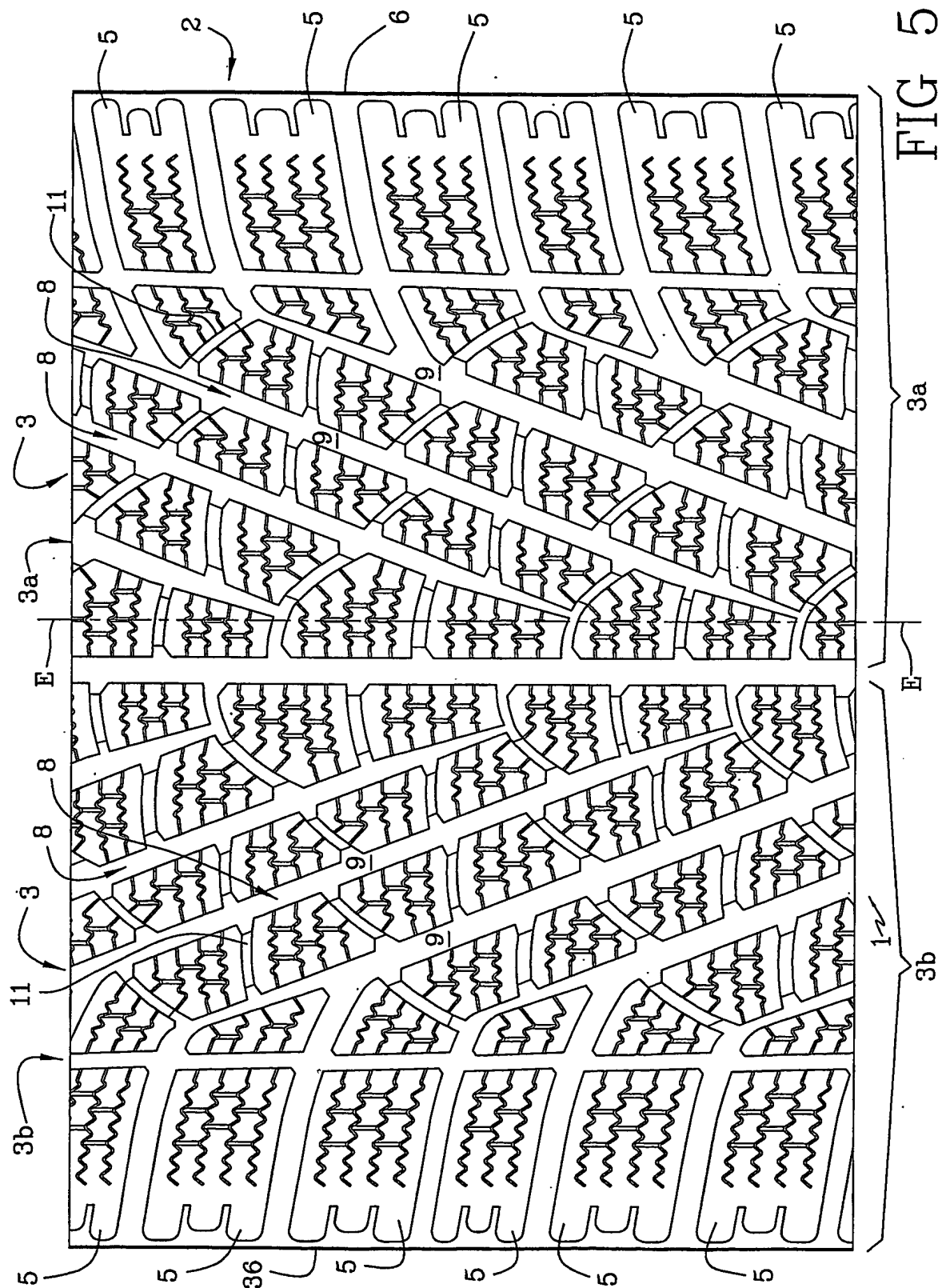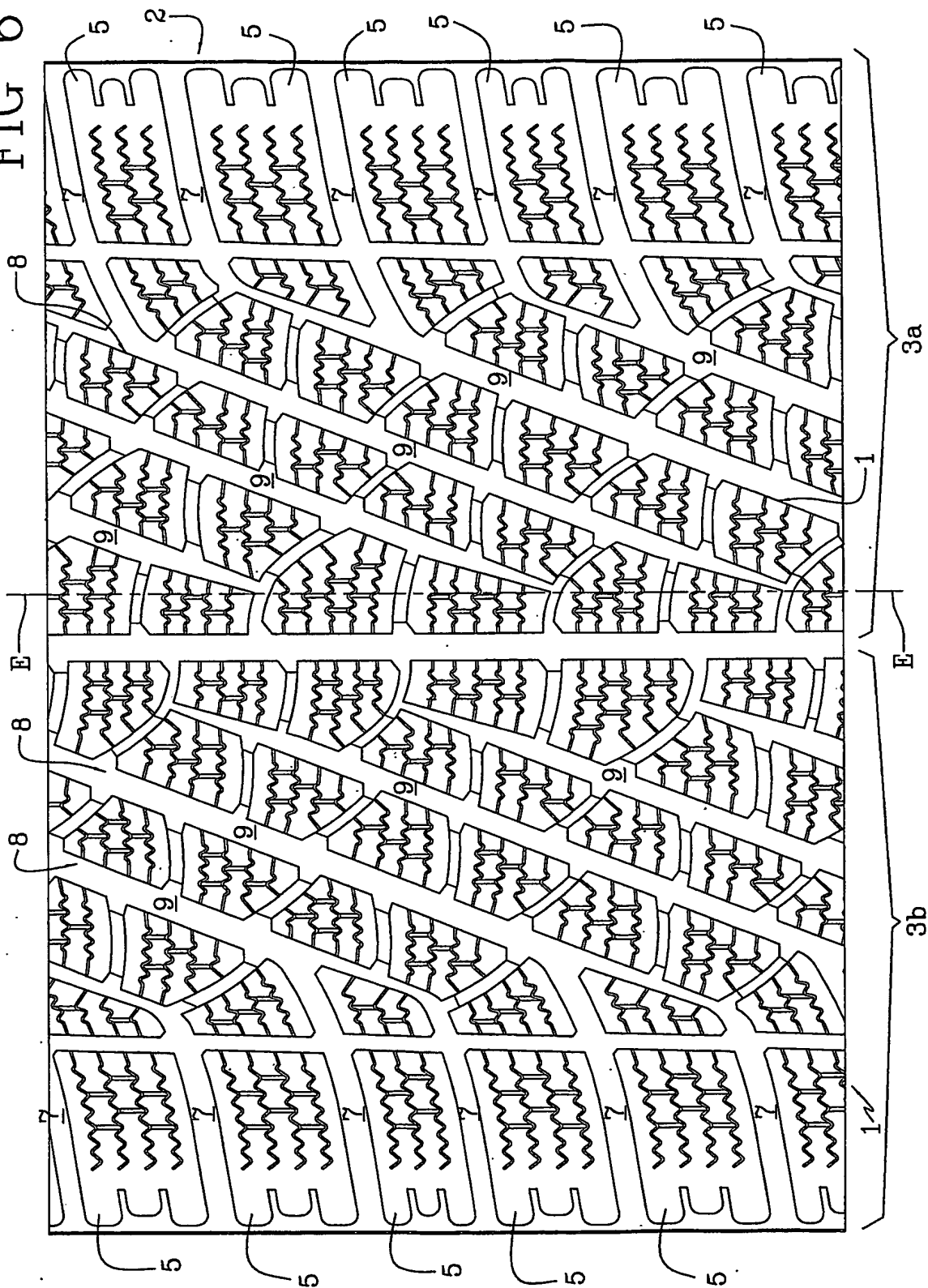30 the elongated ridges (8) of the first circumferential
portion (3a).
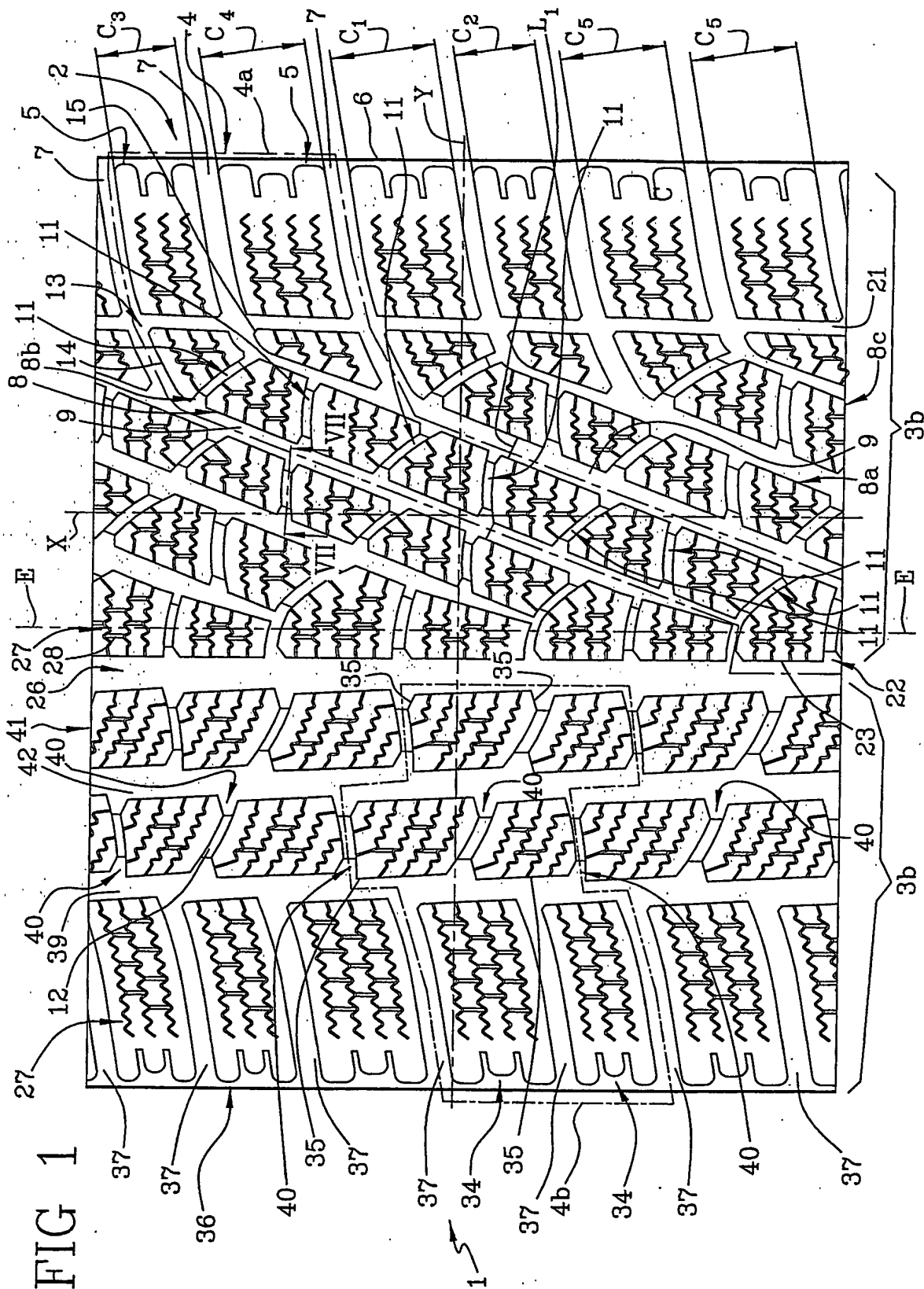
FIG 1

FIG 2

FIG 3

FIG 7

FIG 4

FIG 5
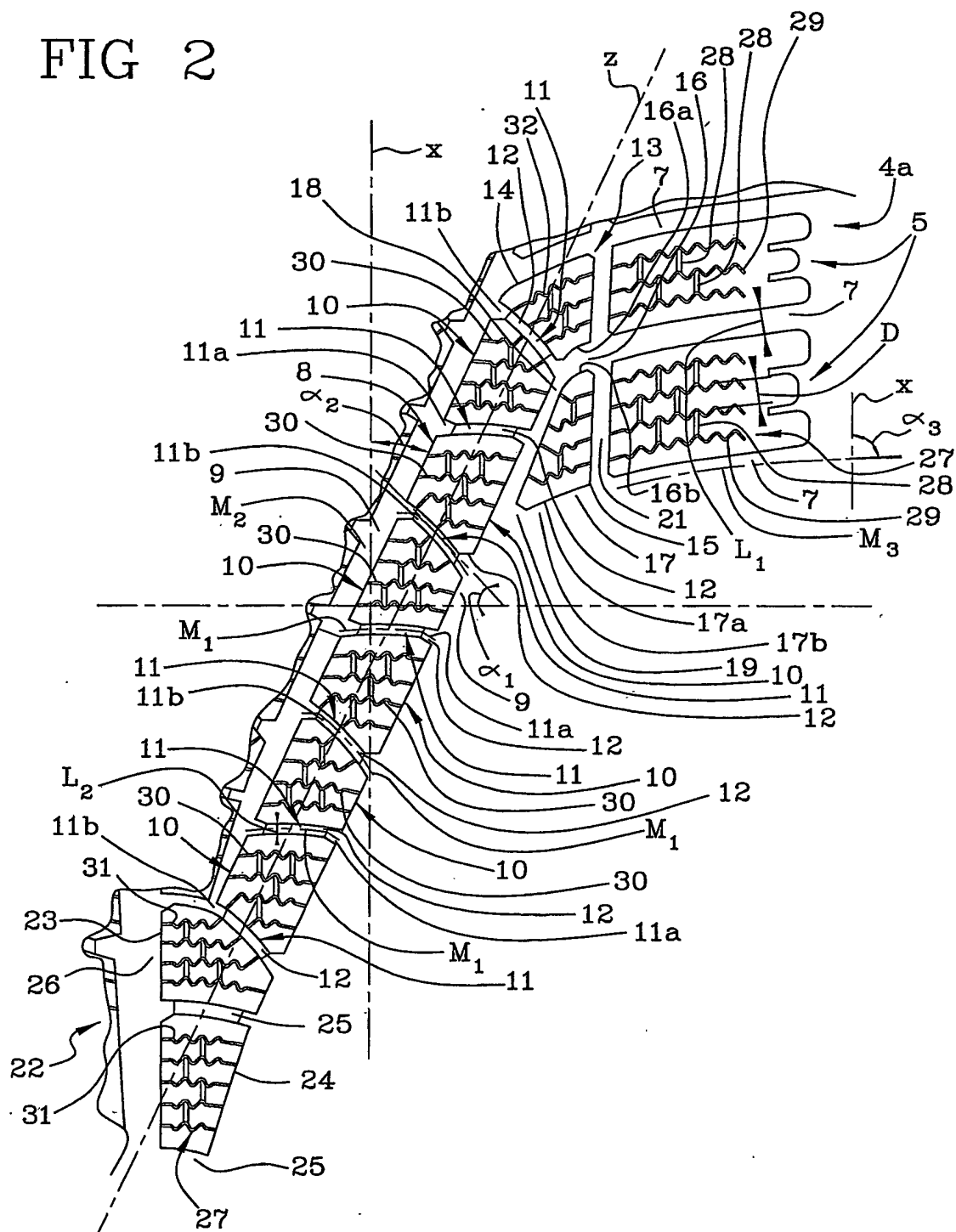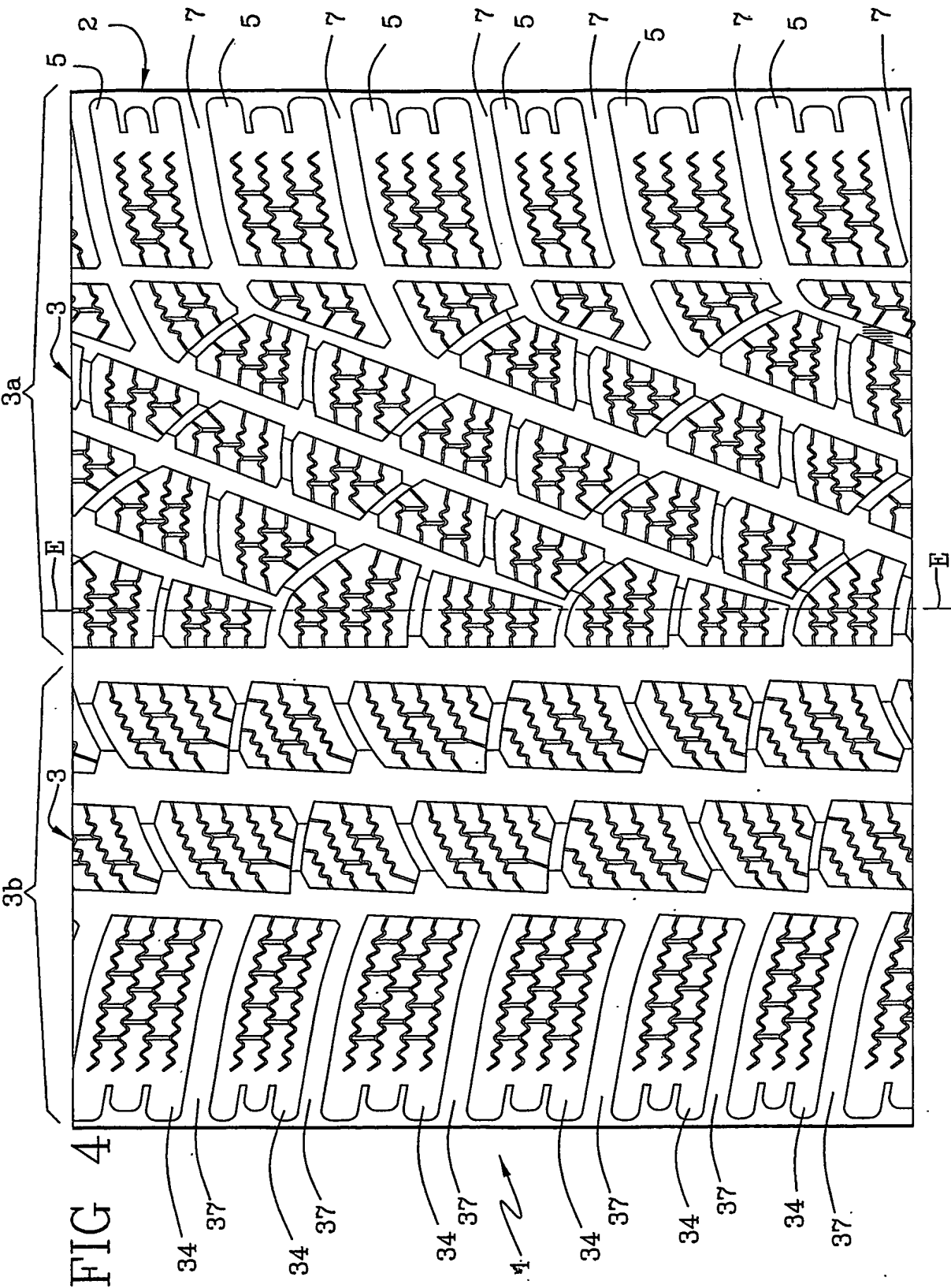
FIG 6

INTERNATIONAL SEARCH REPORT

International Application No

PCT/●●2/00814

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7   B60C11/11   B60C11/12   B60C11/13   //B60C107:00,B60C111:00,
         B60C115:00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7   B60C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 715 973 A (BRIDGESTONE CORP) 12 June 1996 (1996-06-12) page 4, line 14 -page 5, line 44; figures	1-37
X	PATENT ABSTRACTS OF JAPAN vol. 1996, no. 05, 31 May 1996 (1996-05-31) -& JP 08 025917 A (BRIDGESTONE CORP), 30 January 1996 (1996-01-30) abstract; figures	1-37
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[X] Further documents are listed in the continuation of box C.   [X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
3 April 2003	23/04/2003

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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